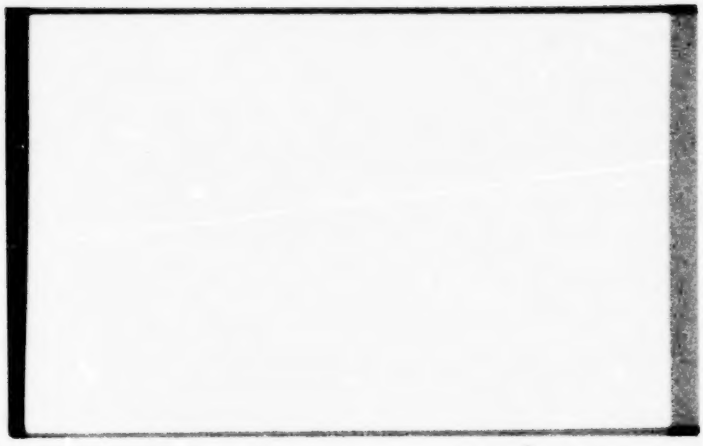
ENERGY USE ENGINEERING DEPARTMENT

PROJECT 8205

B. C. HYDRO -
B. C. MINISTRY OF AGRICULTURE AND FOOD
IRRIGATION SYSTEM
EFFICIENCY MEASUREMENTS

ENERGY CONSERVATION DIVISION

B.C. HYDRO AND POWER AUTHORITY



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PROJECT 8205

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SYNOPSIS:

Alternative methods of electrical and water flow measurements were examined for the proposed irrigation energy efficiency advisory service for B. C. Hydro irrigation customers. A multimeter for the electrical measurements and a non-invasive ultrasonic flowmeter for the water flow measurements provide the most practical and cost effective method.

PROJECT:

Initiated/Requested by:	M. W. Bodnar
Date Completed:	September, 1982
Completed by:	J. Lee
Supervised by:	G.D.A. Henriques
Approved by:	R. W. Racine, Manager Energy Use Engineering

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ENERGY USE ENGINEERING DEPARTMENT

PROJECT SUMMARY

PROJECT NO. 8205 PRIORITY 3

TITLE: Irrigation System - Efficiency Measurements

INITIATED/REQUESTED BY: M. W. Bodnar

ASSIGNED TO: Jinny Lee ASSIGNED BY: G. D. A. Henriques

DATE ASSIGNED: 1982 June 7 DATE REQUIRED: 1982 August 6

ESTIMATED COMPLETION: 1982 August COMPLETED:

OBJECTIVES AND NOTES:

1. Investigate electrical measurements (kW, kW.h, PF) to be used for an irrigation energy efficiency advisory service to B. C. Hydro irrigation customers. List the advantages and disadvantages of the alternate methods and recommend one method.

2. Report on the alternate methods of measuring water flow and recommend one method. (Consider electronic flow measurement.) The examination of these alternates will take place in cooperation with the BCMAF, in a laboratory at UBC in June and field tests in July 1982.

3. The methods that are recommended should be practical and cost effective, i.e. the energy savings available should warrant the expenditure. Consideration should also be given to the amount of time required to conduct the tests.

The project should be formalized in a written report.

COPIES TO: DEPARTMENT MANAGER (THEN RECORD FILE), BLUE FILE, SUPERVISOR, (M.W. Bodnar), G.D.A. Henriques, J. Lee, R. Schneider

PLEASE ADVISE AS SOON AS POSSIBLE IF CHANGES ARE REQUIRED ABOVE

CONTENTS

		Page
1.	INTRODUCTION	1
2.	SUMMARY	1
3.	ELECTRICAL MEASUREMENTS	1
4.	WATER FLOW MEASUREMENTS	2
5.	RECOMMENDATIONS	4

APPENDIX I

Collection of Company Literature on Ultrasonic Flowmeters

1. INTRODUCTION

It was estimated from the pilot test results in 1981 (Project 8116) that a weighted average saving of 19% may be achievable through the proposed B. C. Irrigation Advisory Service Program. In terms of the 1980/81 total sales, this represents a total saving of approximately 7.8 GW.h or $156,000 per year (at 2¢/kW.h).

The proposed program requires accurate and reliable measurements of the input electrical power and the output water power in order to correctly determine the irrigation system efficiency. The purpose of this project is to examine the alternative methods of taking these measurements and to determine the most practical and cost effective methods.

2. SUMMARY

For the electrical measurements, a multimeter which measures the current, voltage and the real power is recommended.

Various types of flowmeters were examined, firstly at UBC pump setup and then at two different farms near Abbotsford. The survey of water flow meters conducted to date has not revealed a meter with sufficient accuracy and reliability. However, it has been determined that the non-invasive ultrasonic flowmeter would offer the most practical and cost effective (instrumentation plus man power) method. None of the flowmeters which have been examined and tested is recommended, but the dual transducer type of ultrasonic flowmeters show much promise.

3. ELECTRICAL MEASUREMENTS

The input electrical power can easily be measured by a wattmeter. The motor performance is examined by comparing the actual current, voltage and power factor of the motor to the manufacturer's recommended values. A multimeter which houses all the functions of an ammeter, voltmeter and a wattmeter is recommended. It is portable, light in weight, DC battery operated and accurate.

One concern over the use of the multimeter is that its clamps are very small in size for the more bulky layouts in the switch boxes. Clamping on the circuit very securely ensures good measurements but the operator must be very careful in handling the clamps and other conducting parts of the switch box. Training in the safe use of the multimeter is essential for any employee who will be required to take the electrical measurements.

4. WATER FLOW MEASUREMENTS

Water flow measurement is required for the calculation of the water power:

$$\text{Water Power Used} = \frac{\text{Flow rate (GPM)} \times \text{Head (ft)}}{3960} \text{ hp}$$

$$\text{Water Power In kW} = \text{hp} \times 0.746$$

In the pilot tests carried out in 1981 the water flow was measured by collecting and measuring the volume of water from individual sprinklers for a certain time interval. This method is impractical for most of the irrigation systems and completely unsuitable for the high pressure systems such as the rain guns. Also, the results obtained by this bucket and stop watch method is unreliable in that it measures the irrigation system efficiency without locating the losses involved. A better method would be to determine the flow rate at the pump discharge and also at the sprinkler discharge so that the pump efficiency may be separated from the possible losses due to poor irrigation design.

Before examining the alternative methods of flow measurement, the following conditions were recognized to exist on the farms:

1. Only a limited number of pumps allow pressure gauge installations.
2. It would be unfavorable to break the pipes.
3. Large variation in pipe sizes.
4. Pipes not always easily accessible - some are buried under ground and do not have any exposure before or after the pump.
5. Leakage could exist in the pipes between the pump and the sprinklers.
6. Irrigation water can vary between very dirty (ditch water) to very clean (well water).
7. 120V AC power outlet may not be available at the pump location.

Taking the above conditions into consideration, the following performance was specified for an ideal flowmeter:

1. Accurate to within 3%, small energy losses due to the meter itself.
2. Reliable to give accurate measurements under various conditions such as water type, pressure level, vibrations and the ruggedness of outdoor farm sites.
3. One meter applicable to all pipe sizes.
4. Non-invasive so that it is not necessary to break into the pipe to install.
5. Portable, uses both AC power and DC batteries.
6. Easy to use so that highly technical staff is not required.

The following table summarizes the alternative methods evaluated against the above specifications. The ultrasonic flowmeter is the most practical and cost effective although it does not meet the accuracy and reliability requirements.

Meter Type	Major Disadvantage
Pitot Tube and Manometer	Invasive
Annubar	Invasive
Venturi	Invasive
Propeller	Invasive, large losses
Commercial integrating	Invasive, large losses
Orifice and Nozzle	Invasive, large losses
Magnetic	Permanent installations
Ultrasonic	Not accurate

Table 1: Summary of various flowmeters available in the present market.

Of the two non-invasive flowmeters, the ultrasonic type is preferable due to its portability. Most of the commercially available ultrasonic flowmeters apply the doppler effect to measure the speed of the fluid passing through the pipe. While this method enables the meter to be used for any pipe sizes, it requires a certain level of impurity in the fluid such as particles or air bubbles which reflect the ultrasonic signals and produce the doppler effect. Although the manufacturers request only 100 parts per mil, it is suspected that the ultrasonic flowmeters do not give very accurate and reliable measurements for the irrigation application because of the lack of particles in the water.

Table 2 gives the summary of various ultrasonic flowmeters examined. Test results of these flowmeters show that none has succeeded in proving satisfactory accuracy.

A rating is given to each flowmeter to indicate which of these flowmeters promises to be a suitable choice. It is suggested that a flowmeter with "poor choice" rating not be considered again. A "probable choice" indicates that with further development (or a better understanding of the meter) it is probable that this meter will prove to be suitable for the proposed Irrigation Advisory Service Program.

5. RECOMMENDATIONS

(i) Use a multimeter for the electrical measurements. There are two multimeters available in EUE, B. C. Hydro.

(ii) When available double check the input electrical power reading with the B. C. Hydro kW.h meter.

(iii) Make certain that the electrical measurements are taken by a qualified person trained in order to ensure safety.

(iv) Maintain an ongoing research on the future developments of non-invasive type of flowmeters in order to identify the most accurate and reliable type.

(v) Pay special attention to the ultrasonic flowmeters, rated above as "probable choice".

(vi) Start the B. C. Irrigation Advisory Service Program only when the most suitable flowmeter is obtained.

Table 2: Summary of various ultrasonic flowmeters examined.

METER/DEALER	OBSERVATIONS
Polysonics Model UFM-PD Davis Controls Ltd.	- single transducer - doppler type - requires particulate matters in water - test results at UBC: UBC (GPM) — Polysonics (GPM) 140.0 — 97.0 16.8 — 16.8 39.6 — 30.7 - $4,564.50 per unit - poor choice
Polysonics Model Hydra DHT-P Davis Controls Ltd.	- twin transducers - doppler type - clean water application - test results at UBC UBC (GPM) — Hydra (GPM) 43 — 33 60 — 50 95 — 88 33 — 31 57 — 53 - accurate results obtained for 6" pipes but not for 3" pipe at the farm sites - $6,085.75 per unit - probable choice
Controlotron Model 183P Modern Instrument Systems Ltd.	- twin transducers - clamp-on doppler - must calibrate for each pipe type and size - test results at UBC not reliable - approximately $4,000 US - poor choice
Controlotron Series 480 Modern Instrument Systems Ltd.	- twin transducers - pulse-time difference principle type - transducers and computer card dedicated to one pipe size and type - clean water application - test results at UBC UBC (GPM) — Controlotron 480 (GPM) 110 — 98 - 105 - approximately $6,000 US - probable choice but most expensive

METER/DEALER	OBSERVATIONS
Bestobell Model P12 F. Drexel Western Ltd.	- single transducer - doppler type - requires particles or air bubbles in water - test results at UBC UBC (GPM) — Bestobell (GPM) 38 — 44 44 — 56 88 — 100 - smallest of all units examined - $1,795 per unit - probable choice with air injection
Soget Model DFP/1 Southwell Controls Ltd.	- single transducer - Doppler type - requires particulate matters in water - test results at farm sites not reliable - $2,145 per unit - poor choice
Mapco	- single transducer - Doppler type - test results at UBC UBC (GPM) — Mapco (GPM) 146 — Calibration set 178 — 161 50 — 48 @ meter setting 5 92 @ meter setting 10 60 @ meter setting 20 7 — no reading - poor choice
Emflux Model D102A Sealand Sales Ltd.	- twin transducers - Doppler type, not tested - flow monitor, NOT flowmeter - $2,970 per unit - poor choice
Sirco Ultrasonic Flow and Level Monitors Sirco Controls	- flow monitor, NOT flowmeter - not tested - poor choice
Pacific Sonic-1010 Pyramid Measurement & Controls Ltd.	- twin transducers - Doppler type - flow monitor, can use as flowmeter but must calibrate each time - test results at UBC not reliable - $2,435 per unit - poor choice